

RADIO OBSERVATIONS OF FOUR ANTICENTER 2CG  $\gamma$ -RAY SOURCES

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## ABSTRACT

The 2CG sources 218-00, 135+01, 121+04 and 95+04 have been observed at two radio frequencies and the flux values and spectra of the radio sources observed within the  $\gamma$ -ray fields are catalogued down to a sensitivity of  $\sim 30$  mJy at  $\lambda 11$  cm. Possible  $\gamma$ -ray counterpart candidate objects are briefly discussed.

1. Introduction. Identification of  $\gamma$ -ray sources suffers from the angular indeterminacy of their positions ( $\Delta\theta \sim 1^\circ$ ). Our program to help their identification aims at the radio mapping of the regions at least at 2 frequencies, allowing a catalogue of radio sources with spectra and fluxes down to  $\sim 30$  mJy sensitivity limit at  $\lambda 11$  cm. Possible scenarios in view of the present observations are briefly given at the end.

2. Observations. Using the 100-m Effelsberg telescope of the MPIfR error boxes as given by Swanenburg et al. (1981) are mapped in radio continuum at frequencies 1420 MHz ( $\lambda 21$  cm), 1720 MHz ( $\lambda 18$  cm), 2700 MHz ( $\lambda 11$  cm) and 4750 MHz ( $\lambda 6$  cm). Each  $\gamma$ -ray region has been scanned at least at two of these frequencies to facilitate spectral information about the detected sources. Interesting fields have also been searched for polarization characteristics. Here, only one map for each source is reproduced with some information about observations. Further details can be found in Özel et al. (1985a, hereafter referred to as Paper I).

3. Results. The resultant maps for the fields (1 map for each) are given as Figures 1, 2, 3 and 4, respectively. Source lists and other more detailed information are given in Paper I. Important radio objects for each  $\gamma$ -ray source field will be discussed below.

218-00: This field (Fig. 1) contains the extended source 0657-040, which is a catalogued HII region (S287 in Sharpless (1959)) and needs to be considered further. Scenarios based on the excess activity in star formation complexes require an enhancement of CR flux by a factor  $f \geq 10$  as compared to solar cosmic ray densities. A hidden supernova near or within the cloud is needed to connect the observed  $\gamma$ -ray activity to 0657-040.

135+01: The major radio object in the field (Fig. 2), W4, covers almost the total area. Scenarios similar to 218-00 under more favorable conditions seem to be at work as suggested by Montmerle (1979) and others. The "source" 0024+617 (which is part of the W4 complex) with its enormous ( $\sim 50$  pc) jet-like protrusion might have important implications for the nature of W4 in general.

121+04: A previously unknown extended feature has been discovered in this field (Fig. 3). Preliminary calculations (polarization, morphology) indicate that it probably is a SNR of age  $\lesssim 10^5$  yrs. The center-filled nature suggests a Crab-like pulsar mechanism by a fast compact object, and

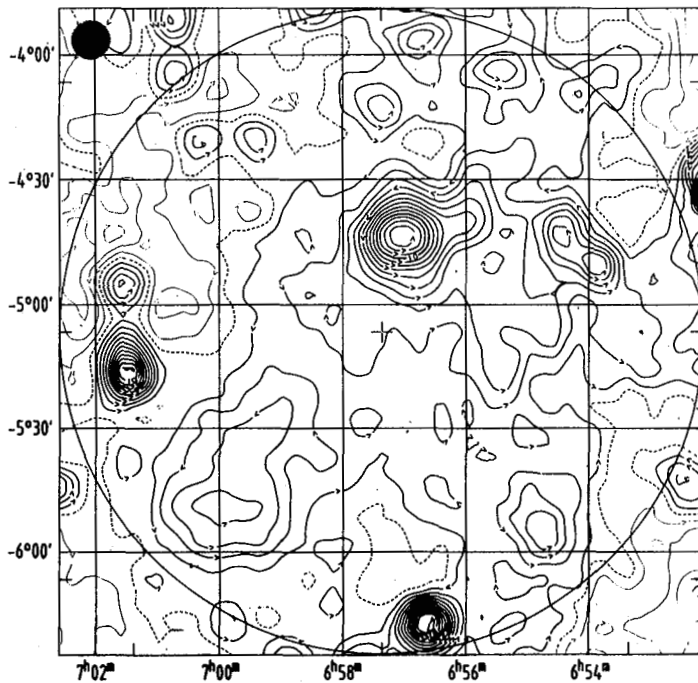


Fig. 1:  
2CG218-00 field at  $\lambda 21$   
cm. Circle denotes 90%  
COS-B error box. Zero  
level is dashed. Contour  
step size ( $1\sigma$ ) is 19 mJy.  
Maxima are enclosed by  
CCW arrows. 0657-040  
lies at upper center.  
(HPBW is  $9.4 \times 9.4$ , the  
circle at upper-left  
corner.)

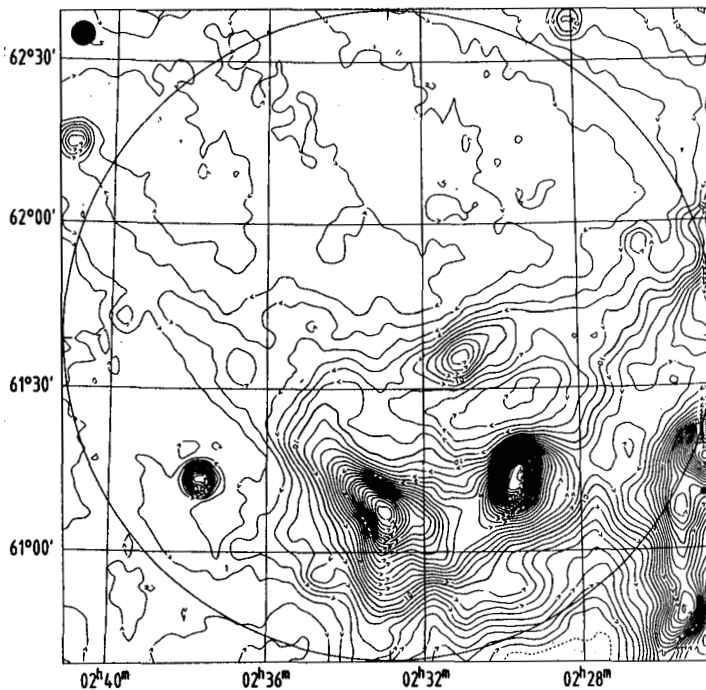


Fig. 2:  
2CG135+01 field at  $\lambda 11$   
cm. The first contour  
above zero is at 15 mJy  
( $1\sigma$ ). Subsequent con-  
tours are at  $3\sigma$  inter-  
vals. HPBW is  $4.4 \times 4.4$ .  
A protrusion starting  
from 0024+617 (lower  
center) towards  $\delta \approx 62.1$   
is observable.

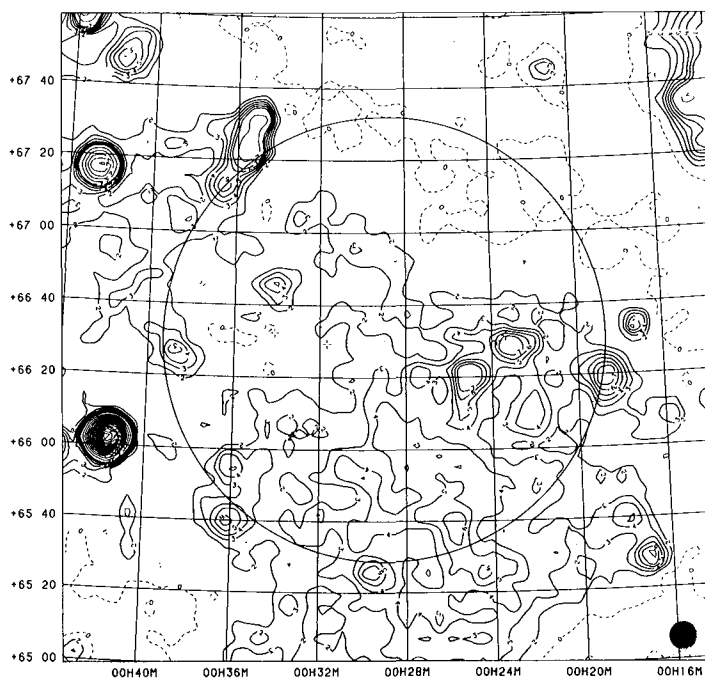


Fig. 3:  
2CG121+04 field at  $\lambda 18$   
cm. The first contour  
above dashed (zero)  
level is at 60 mJy ( $2\sigma$ );  
subsequent contours are  
separated by  $1\sigma$ . The  
extended feature  
G120.6+3.2 is approxi-  
mately centered at  $\alpha \approx$   
0h26m,  $\delta \approx 65^\circ 40''$  and  
has a center-filled  
morphology. It is  
tentatively identified  
as a supernova remnant.

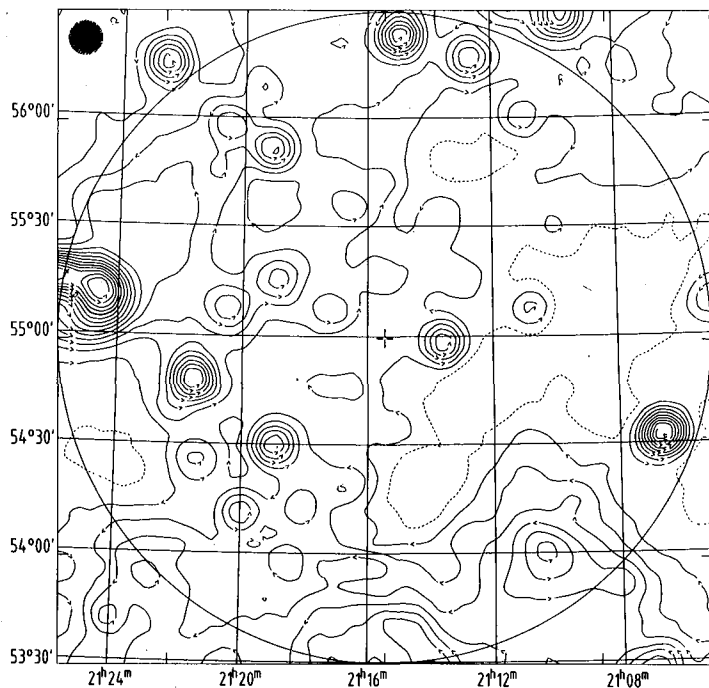


Fig. 4:  
2CG095+04 field at  $\lambda 21$   
cm. Contours are sepa-  
rated by 24 mJy ( $2\sigma$ ).  
HPBW as in Fig. 1.

such a search (for  $P \geq 5$  ms) has been undertaken as a further work for this field (Özel et al., 1985b).

95+04: This field (Fig. 4) is full of (extragalactic?) non-thermal radio sources. Near to its center lies one of the few flat-spectrum sources, 2116+541. Cold dark matter in the region is already catalogued as LDN 1060, 1062, 1072 by Lynds (1962). Diffuse mechanisms of enhanced CR-matter interactions might be at work in this field.

4. Conclusion. These new observations give us further information about the objects in the 4  $\gamma$ -ray source fields. Tentative scenarios noted above are by no way conclusive. Further work is required to understand the message of radio observations.

#### References

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